Attorney Docket: 14391

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: EXTRUSION APPARATUS AND METHOD AND EXTRUDED FOAM ARTICLE

APPLICANT: HARTMAN, STEVEN

EXTRUSION APPARATUS AND METHOD AND EXTRUDED FOAM ARTICLE

FIELD OF THE INVENTION

[0001] The present invention relates to an extrusion apparatus and method, and more particularly to an apparatus for forming extruded foam articles having a visual surface characteristics, and method.

BACKGROUND OF THE INVENTION

[0002] Extruded foam articles, made from materials such as polyolefin foam, are used in various applications. Such foam articles are for example often used for pipe insulation, as packing material, as components of children's furniture, as protective covers, or as floating toys for use in swimming pools.

[0003] In many of these applications, the appearance of the outer surface of the foam impacts the overall attractiveness of the foam article, and thus its value to a consumer. This is particularly acute with toys, protective covers, and furniture, for which purchase decisions are based almost exclusively on the appearance of the article. To this end, U.S. Patent No. **6,183,673**, for example, discloses a process for forming a surface coating or skin on an extruded foam article. The coating may be coloured, allowing the formed article to have a desired uniform colour different from the colour of the underlying foam.

[0004] Although attractive, articles having this single colour still provide limited variety and choice to consumers. Although new colours may be periodically introduced, a mere change in colour is typically insufficient to energize consumer interest. Greater variations in appearance may, of course, be achieved by applying aesthetic features on the article by hand. This, however, is labour intensive and ultimately costly.

[0005] Clearly then, a new method and apparatus for forming an extruded

foam article and inexpensively imparting a desired visual characteristic on the surface of the article is desirable.

SUMMARY OF THE INVENTION

[0006] The present invention provides an apparatus and method for imparting a desired visual characteristic on the outer surface of an article, and the article formed thereby.

[0007] In accordance with a first aspect of the invention, there is provided a method of extruding a foam article, comprising: urging a first foam material to an extrusion channel, said first foam material having an outer surface within said extrusion channel; feeding a first coating material to an applicator in communication with said extrusion channel to apply a visible coating on a region of said outer surface of said first foam material within said extrusion channel, said region occupying a fraction of a perimeter of said outer surface.

[0008] In an embodiment, the method may further comprise rotating said application relative to said foam material about an axis parallel to the direction of travel of said first foam material through said extrusion channel proximate said applicator, thereby imparting a visible helical bank on said extruded article.

[0009] In another aspect of the invention, there is provided an extruded foam article formed in accordance with the method as recited above.

[0010] In another aspect of the invention, there is provided a flotation aid formed in accordance with the method as recited above.

[0011] In another aspect of the invention, there is provided an extrusion apparatus, comprising: a main die body having a first extrusion passage for allowing a flow of a first foam material to flow therethrough; a rotary die body rotatably mounted to said main die body, said rotary die body having a rotary applicator aligned with said first extrusion passage of said main body; a secondary supply channel in flow communication with said applicator, to provide a

continuous flow of a first coating material to said applicator, as said first foam material flows through said rotary applicator.

[0012] This and other aspects of the invention will become apparent through the illustrative figures and accompanying description provided below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In the figures which illustrate example embodiments of this invention:

[0014] **FIG. 1** is a partial cross-section of an extrusion apparatus exemplary of an embodiment of the present invention;

[0015] **FIG. 2** is a bottom view of the extrusion apparatus of **FIG. 1**;

[0016] **FIG. 3** is a perspective view of a bearing plate in the extrusion apparatus of **FIG.1**;

[0017] **FIG. 4** is a perspective view of a rotary die body in the extrusion apparatus of **FIG. 1**;

[0018] **FIG. 5** is a perspective view of a die head of the apparatus of **FIG. 1**;

[0019] **FIG. 6** is a perspective view of an article formed with the apparatus of **FIG. 1**;

[0020] **FIG. 7A** and **FIG. 7B** illustrate the extrusion apparatus of **FIG. 1**, in operation; and

[0021] **FIG. 8** illustrates an alternative embodiment of the rotary die body of **FIG. 4**.

DETAILED DESCRIPTION

[0022] **FIGS. 1** and **2** illustrate an extrusion apparatus **10** exemplary of an embodiment of the present invention. As will become apparent, extrusion apparatus **10** may be used to form an extruded article, such as the example extruded article **12** depicted in **FIG. 6**.

[0023] Extrusion apparatus **10** includes a main die body **20**, a bearing plate **30**, a rotary die body **40**, a die head **50**, and a protective cup guard **51**.

[0024] Main die body **20** includes an extrusion passage **22** which allows a first foam material, such as foams of polyolefins, EVAs (ethyl vinyl acetates), polypropylene, and any other foamable thermoplastic polymer to be urged therethrough. Additionally, main die body **20** further includes a secondary supply channel **24**. Secondary supply channel **24** allows a flow of a coating material to impart a coating on the extruded primary foam as it is being extruded. Secondary supply channel **24** includes an inlet **24a**, a horizontal channel section **24b**, and an angled channel section **24c**. Angled channel section **24c** is in fluid communication with a second angled channel section **24d**, which is formed in bearing plate **30**. Outlet of the secondary supply channel **24** is shown at **24e**. The general shape of secondary supply channel **24** is illustrative, and it will be appreciated that many different shapes are possible.

[0025] Bearing plate **30** is mounted to main die body **20** by, for example, a mounting screw **31** which passes through a mounting hole **33** provided in the bearing plate **30**.

[0026] **FIG. 3** is a perspective view of an example bearing plate **30**. As illustrated, bearing plate **30** includes a further mounting screws **31** that is axially aligned with the mounting screws **22** in main die body **20** (as best viewed in **FIG. 1**). A plurality of mounting holes **33** may be provided at suitable locations to secure the bearing plate **30** onto the main die body **20**. Example bearing plate **30** has an orifice **24d** which forms a section of secondary supply channel **24**.

[0027] Rotary die body **40** (**FIG. 1**) rotatably engages bearing plate **30**. A

plurality of cam rollers **56a**, **56b**, **56c** (**FIG. 2**) provide a constant biasing force which keeps the rotary die body **40** continuously engaged against the bearing plate **30**. For clarity of illustration cam roller **56c** is not shown in **FIG. 1**. Rotary die body **40** may be rotated about its central axis by a drive gear **58** engaging the rotary die body **40**. For example, rotary die body **40** may be provided with gear teeth **41** for engaging corresponding gear teeth **57** on the drive gear **58**. Alternatively, rotary die body **40** may be rotated by a gear arrangement on the rollers **56a – 56c**, or by a belt around the rotary die body **40**. Various other ways of rotating the rotary die body **40** will be apparent to those skilled in the art. As further illustrated, rotary die body **40** includes an additional extrusion passage **42**.

[0028] A protective cup guard **51** (**FIG. 1**) may be provided on the rotary die body **40** to prevent an expanding extruded article from accidentally contacting the cam rollers **56a**, **56b**, **56c**. Protective cup guard **51** is not shown in **FIG. 2**.

[0029] Extrusion die **50** may be provided with a mounting hole **53** to mount extrusion die **50** onto rotary die body **40** with a fastener, such as a screw (not shown). Extrusion die **50** includes a further extrusion passage **52**.

[0030] The central axes of extrusion passage **42**; extrusion passage **22** in main die body **20**; extrusion passage **32** in the bearing plate **30**; and extrusion passage **52** in extrusion die **50**, are axially aligned and combine to form an extrusion channel **28**. Extrusion channel **28** provides a passage through extrusion apparatus **10** for the first foam material, which is extruded at die egress **54** and forms the main body of an extruded foam article. In an embodiment, each extrusion passage **22**, **32**, **42**, **52** may have generally inwardly tapering walls leading towards the die egress **54**.

[0031] Secondary supply channel **24** feeds an annular reservoir **44**, as best viewed in **FIG. 1**. Annular reservoir **44** is, in turn, in fluid communication with feed channels **46** in rotary die body **40**. In the depicted embodiment, four feed channels **46** discharge into extrusion passage **52** between the egress of extrusion passage **42** of the rotary die body **40** and the ingress of extrusion passage **52** of the extrusion die **50**.

[0032] Feed channels **46a – 46d** (individually and collectively **46** – best viewed in **FIG. 2**) are positioned at equal angular spacings about the central axis of extrusion channel **28** to provide fluid communication between the annular reservoir **44** and the extrusion passage **52** in the extrusion die **50** (**FIG. 1**). As will become apparent, the number and spacing of feed channels **46** ultimately govern the appearance of the coating of an extruded article. The number and spacing may be readily varied as desired.

[0033] **FIG. 4** is a perspective view of rotary die body **40**. As illustrated, die body **40** is generally disc shaped and includes a circular recess **43** axially aligned with the central axis of the rotary die body **40**. Recess **43** is appropriately dimensioned, in depth and in diameter, to receive bearing plate **30** (as shown in **FIG. 1**). Annular reservoir **44** is nested within recess **43**. Inlets to feed channels **46** are again illustrated.

[0034] When bearing plate **30** and rotary die body **40** are engaged, as shown in **FIG. 1** bearing surface **35** of bearing plate **30** abuts rotary die body **40**, and thereby encloses the annular reservoir **44**. Outlet **24e** of the secondary supply channel **24** is aligned with the annular reservoir **44** so that secondary supply channel **24** maintains continuous fluid communication with the annular reservoir **44** as rotary die body **40** rotates relative to main die body **20**.

[0035] Extrusion die **50** is more particularly illustrated in **FIG. 5**. As shown, extrusion die **50** is generally disc shaped, and exemplified extrusion passage **52** is generally funnel-shaped: the wall of the extrusion passage **52** tapers as the passage **52** extends from the ingress of the passage to egress **54** of extrusion die **50**. As will become apparent, extrusion passage **52** of extrusion die **50** acts as an applicator, to apply a coating to the outer surface of the article **12** (**FIG. 6**) as it is being extruded.

[0036] **FIG. 6** depicts an illustrative extruded article **12** that may be formed by the extrusion apparatus **10** of **FIG. 1**. As illustrated, extruded article **12** may include a core or main body **14** having an outer surface **16**. In the depicted embodiment, outer surface **16** includes a coating taking the form of several helical

bands **18**. Each band **18** has a colour that contrasts an area of the surface of the article adjacent the bands **18**. In the illustrated embodiment, extruded article **12** is formed having four equally spaced helical bands **18**. As shown, the helical bands **18** occupy a region representing a fraction of a perimeter of the outer surface **16**.

[0037] As will become apparent, the helical band or bands **18** may be imparted on the surface of the main body **14** by extruding a first foam material through the extrusion apparatus **10**, while applying a coating material forming the band **18** by way of extrusion die **50** that rotates relative to the main die body **20**, and extrusion channel **28**. The helical bands **18** provide an attractive visual characteristic on the surface of the extruded article **12**, and the main body **14** made of a foam material provides buoyancy, allowing the extruded article **12** to be used as a swimming aid.

[0038] In operation, a first foam material is fed into extrusion channel **28**. The first foam material is preferably a mixture of a suitable extrudable material, such as polyolefin, and a foaming agent for expanding the polyolefin material upon extrusion. Within extrusion channel **28**, the first foam material begins to assume a shape having a relatively uniform cross-section, corresponding to that of the extrusion channel. At the same time, the secondary supply channel **24** is fed with a coating material, preferably having a colour that contrasts that of the first foam material. Preferably the coating material is compatible with the first foam material, but coloured. Colouring may be achieved by way of a dye, or the like. The flow of the first foam material and the coating material to form article **14** is illustrated in **FIG. 7A** and **FIG. 7B**.

[0039] The first foam material flows through passages **22**, **32**, and **42** and enters rotating passage **52**. .

[0040] Rotary die body **40** (and thus extrusion die **50** and extrusion passage **52**) are rotated relative to the main die body **20**. Specifically, rotation of the drive gear **58** in direction A by a motor drive (**FIG. 2**) causes the rotary die body **40** to rotate in direction B, as illustrated. The wall of passage **52** rotates about and relative to the first foam material, being extruded through channel **28**.

[0041] At the same time, the coating material enters passage **52** from feed channels **46**. The coating material flows from the point of exit of each channel **46** along the interior wall of passage **52**, and rotates with the wall of passage **52**. As the coating material flows downward along the wall of passage **52**, it disperses circumferentially along the wall of passage **52**. As a result, the coating material covers an area larger than the width of the outlet of each channel **46**. . The coating material then makes contact with the surface of the first foam material, in passage **52.**

[0042] As a result, the region of application of each feed channel **46** rotates about the central axis of passages **52**, and extrusion channel **28**. This relative rotation causes the coating material to come into contact with the surface of the first foam material within extrusion channel **28**, at varying angular locations about the axis of extrusion channel **28**, proximate the region of application as the first foam material moves along the axis of the extrusion channel **28**. As applied, the coating from each feed channel **46** colors less than the entire outer perimeter of the main body **14** in passage **52**. As a result, the coating material takes the form of helical bands **18**, occupying a region representing a fraction of a perimeter of the outer surface **16** of the extruded article **12**, as illustrated in **FIG 7A**. Each feed channel **46** forms a single helical band **18** on the extruded article **14**. The number of bands **18** and the appearance of article **12** may thus be varied by varying the number and spacing of the feed channels **46** and the speed of rotation of the rotary die body **40.**

[0043] It will be appreciated that, in an embodiment, of the rotary die body **40** is not rotating, then bands will be formed on the extrude article **14.**

[0044] The combination of the first foam material and coating material exits extrusion apparatus **10** at egress **54** of extrusion die **50**. As this combination exits, it expands uniformly due to the active foaming agent mixed in the first foam material. The degree of expansion may be controlled by, for example, selection of the foaming agent, control of the amount of foaming agent used, the temperature of the combination, and the relative drop in pressure once the combination exits egress **54**. Protective cup guard **51** prevents the extruded, expanding article **12**

from accidentally contacting rollers **56**. Conveniently, the coating material may be formed from material that has suitable expansion characteristics, so that the coating material expands at the same rate as the first foam material. This retains the helical band appearance on the outer surface **16** of the main foam body **14** as it expands substantially. Moreover, the coating material remains on or near the surface of the main foam body **14**. Typically, the first foam material may expand in volume by a factor of 10 to 50 with the coating material expanding correspondingly on the surface of the first foam material. As the combination cools, it hardens in its extruded form. Conveniently, if the coating material is of the same material as the first foam material, the texture of the outer surface **16** of the formed article **14** is generally uniform. As well, as the coating material is only applied to the outer surface **16**, the quantity of coating material required is only a small fraction of the quantity of first foam material used to form article **14**.

[0045] As should now be appreciated, the apparatus of **FIG.1** may easily be modified to allow application of helical bands of multiple colours to an extruded article. For example, **FIG. 8** shows an alternative embodiment of rotary die body **40**. In this alternative embodiment, a second annular reservoir **64** is shown formed in the recess **43**. As with the first annular reservoir **44**, the second annular reservoir **64** is axially aligned with the axis of rotation of the rotary die body **40**. In this alternative embodiment, two feed channels **46a**, **46c** remain in the inner annular reservoir **44**. However, two new feed channels **66a** and **66b** are now shown in the outer annular reservoir **64**, spaced approximately 90 degrees apart from feed channels **46a**, and **46c**. Reservoir **64** may now be fed by a second secondary supply channel **24'**, that could extend through body **20**, that may provide a coating that may be visually distinct from both the first foam material, and the coating material provided by way of the first secondary supply channel **24 (FIG.1)**.

[0046] As should also be appreciated, instead of using colored dyes, it may be possible to add other appealing visual characteristics. For example, fine reflective particles of various colors (e.g. gold, silver, green, red, blue) may add a glittering or sparkling helical band appearance. . It will be apparent to those

skilled in the art that numerous other appealing visual characteristics may be imparted on the outer surface **16** of an extruded article **12** in the manner described herein.

[0047] Similarly, although the cross section of passages **22**, **32**, **42** and **52** have been illustrated as circular, a variety of other cross-sections are possible. For example, the cross-section of passage **52** could be square, rectangular, oval or a variety of other shapes, thereby shaping an extruded article.

[0048] Additionally, while the bearing plate **30** may be provided to avoid wear on the main die body **20**, it will be appreciated that, in an alternative embodiment, a bearing surface for engaging the rotary die body **40** may be formed directly on the main die body **20** itself. While the extrusion die **50** in **FIG. 1a** is shown as a separate piece attached to the rotary die body **40**, it will be appreciated that, in an alternative embodiment, such a extrusion die **50** may be formed integrally with the rotary die body **40**. Various other modifications, including non-planar engagement (e.g. a shallow conical engagement) between any of the components (e.g. between the bearing plate **30** and the rotary die body **40**), will also be apparent to those skilled in the art. Also, while the annular reservoir **44** is shown formed entirely in the rotary die body **40**, it will be appreciated that in an alternative embodiment a portion of, or all of, the annular reservoir **44** may be formed on the bearing plate **30**.

[0049] The exemplified extrusion apparatus are illustrative and are not to be construed as limiting the invention to the specific embodiment shown. Other modifications will be apparent to those skilled in the art and, therefore, the invention is defined in the following claims.